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Sensitivity of Aerosol Radiative Forcing Calculations to Spectral Resolution

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The impact of aerosol radiative forcing on climate has been of considerable recent interest. In particular, direct and indirect forcing by aerosols is thought to have masked the expected global warming from observed anthropogenic increases in carbon dioxide and methane concentrations. To estimate aerosol forcing, spatially and chemically varying aerosol distributions are developed within a general circulation model (GCM). The resulting forcing is then estimated by in-line radiative transfer calculations.

Radiative transfer models commonly included within GCM's have been optimized to use the minimal spectral resolution needed to calculate net heating rates in the presence of absorbing gases and Rayleigh scattering. For example, a typical solar radiation model might have one to three UV bands, one visible band, and one near-IR band (with five to seven k-distribution terms). Optical properties of aerosols, when included, have been treated as being spectrally invariant over large bands (UV, visible, near-IR, IR).

In contrast, calculations of optical properties of realistic size distributions of aerosols that are mixtures of ammonium sulfates, sulfuric acid, soot, organic carbons and mineral dust can have significant spectral variation. This situation is further complicated by the spatially inhomogeneous response of aerosol size distributions and composition to changes in relative humidity. If such spectral variation in aerosol properties is significant within a model band and if it correlates with spectral variation in Rayleigh scattering or gaseous absorption within the band, estimates of aerosol forcing will be inaccurate. In this paper we investigate the potential magnitudes of such forcing errors and the spectral requirements for accurate aerosol forcing estimation.

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